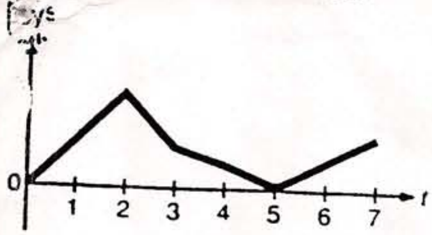
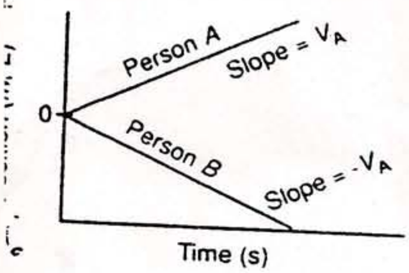
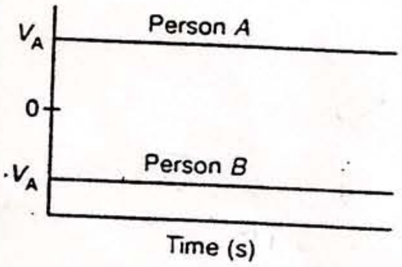
2.1 They would get opposite signs for velocity and displacement, and equal speeds and distances.

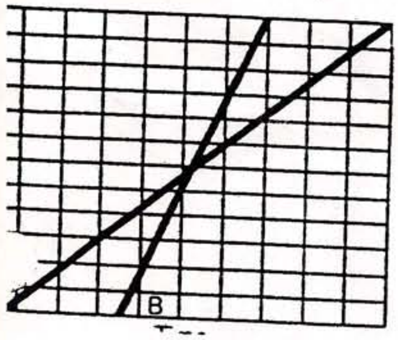


2.3 Call east the position direction and person A is the one who walks east. The position-time graph of person A is a straight line with a constant positive slope, v_A. Person B's straight line has a constant negative slope of $-v_A$. The velocity-time curve for person A is a horizontal line with a constant value of v_A; person B is a horizontal line with a constant value of $-v_A$.





Critical Thinking: No. They l the same position, not velocity. To have the same velocity, they would have had to have the same relative position for a length of time.



REVIEWING CONCEPTS

1. A football is treated as a point when the conditions under study require a frame of reference beyond the football itself. For instance, it is treated as a point when you want to know how high or how far it travels; or, how long it is in the air (its "hang time"). However, when the conditions under study concern a frame of reference that only includes the football itself, it cannot be treated as a point. It must be treated as a football. For instance, questions about its spin or end-over-end motion include only the ball itself.

2. A scalar has only magnitude; a vector has magnitude as well as direction.

3. Displacement is a vector.

4. Average velocity is a vector.

5. The slope of a position-time graph is velocity.

6. a. Yes. If you sit on a merry-go-round and look straight ahead, you see that your direction is changing; your velocity is therefore changing. For most of the ride, your speed remains constant. Hold the book out from your body and twirl around at a constant rate. b. No. Any change in speed will change the size of the velocity.

7. Both are straight lines that start at the same position, but the slope of the runner's line is steeper.

8. It is possible to calculate the average velocity from the information given, but it is not possible to find the instantaneous velocity.

9. the change in displacement

10. The car starts from rest and increases its speed. As the car's speed increases, the driver shifts gears.

APPLYING CONCEPTS

1. No. Car A's position would now be +5.0 m and Car B's position would be −4.0 m.

2. Yes. The distance between the cars would remain 9.0 m.

3. The space shuttle travels a greater distance (scalar quantity) around Earth in getting to Edwards Air Force Base. Its displacement (vector quantity), however, is the position of its landing point, Edwards Air Force Base, minus its starting (reference) point, Cape Canaveral, which is the same for the astronauts as it is for the NASA team.

4. The ratio is large when the object is moving slowly, and small when it is moving quickly. It can never be zero because it would have to have two positions in a zero time interval.

5. If the average velocity for a time interval is zero, the displacement for that time interval is zero. The distance may be non-zero.

6. a. The graph represents constant velocity. b. the value of the constant velocity

7. A–B, increasing; B–C, constant; C–D, decreasing; D–E, zero; E–F, increasing negative; F–G, constant negative; G–H, decreasing negative

8. a. Runner A has a head start by four units. b. Runner B is faster since the slope is steeper. c. Runner B passes Runner A at point P.

9. a. when the positions are the same, at 1.4 s and 8.2 s; b. Car A has a steeper slope and a larger velocity. c. at 4 s, when the slopes are the same; d. at no interval; e. Always, because the slope is always decreasing.

10. a. The graph represents motion with a constant positive velocity. b. The area under the curve represents the change in displacement.

11. a. The graph represents motion with a positive increasing velocity. b. The area under the curve represents the change in displacement.

Chapter 3 pp 57-61

1. a. 45 miles
   b. −[illegible]
2. −85 km
3. a. zero displacement
   b. 6.0 m
4. 1.5×10^{11} m
5. 1.8 minutes
6.

Length of event (m)	Speed (m/s)	
	Men	Women
100	10.1	9.488
200	10.13	9.372
400	9.118	8.222
800	7.688	6.891
1500	6.9457	6.4114
3000		5.9227
5000	6.3155	
10000	6.09214	5.36133

7. Student answers will vary.
8. Student answers will vary.
9. a. 14 km/h, west
   b. no
10. 11 m
11. a. 720 km/h
    b. no
12. a. 50 km/h
    b. no, 48 km/h
13. a. Refer to Problems and Solutions Manual.
    b. parabola
    c. 10 m
14. a. 400 m
    b. 0
    c. −200 m
15. a. Refer to Problems and Solutions Manual.
    b. 150 km, 170 km
    c. 1.3 h, 1.2 h
16. Refer to Problems and Solutions Manual. Both cars arrive at 1:00 P.M.
17. Refer to Problems and Solutions Manual. 8.0 m/s
18. a. Refer to Problems and Solutions Manual.
    b. 550 m
    c. 300 m
19.

Time Interval(s)	Average Velocity (m/s)
0–10	10
10–20	10
20–30	10
30–40	10
40–50	0
50–60	0
60–70	0
70–80	−10
80–90	−10
90–100	−20

20. Refer to Problems and Solutions Manual.
    a. 6.0 h
    b. 2.6×10^2 km
    c. 7.3 h

CHAPTER 3

1. **a.** Velocity increases rapidly at first, then more slowly. Acceleration is greatest at the beginning, but is reduced as velocity increases. Eventually it is necessary for the driver to shift into second gear. **b.** The acceleration is smaller just before the gear change because the slope is less at that point on the graph. Once the driver shifts and the gears engage, acceleration and the slope of the curve increase.

2. The average acceleration is largest in the time interval zero to one second and smallest during the last second. The instantaneous acceleration varies over each interval, starting large and decreasing. It actually becomes zero at points where pauses due to shifting gears occur.

3. $v_f = v_i + at$, so $v_f - v_i = at$, and

$$a = \frac{v_f - v_i}{t} = \frac{\Delta v}{t}$$

This is the equation for acceleration.

4. **a.** The curve is a parabola. **b.** The slope of a line tangent to the curve represents the instantaneous velocity at that point. **c.** The slopes would be larger at higher points, indicating larger velocities.

5. Both objects have traveled the same distance. The object shot straight up rises to the same height from which the other object fell.

6. Velocity is reduced at a constant rate as the ball travels up into the air. As the ball begins to drop, the velocity again begins to increase until it reaches the height from which it was initially released. At that point, the ball will have the same velocity it had upon release. The acceleration is constant throughout its flight.

7. **a.** The ball will hit the moon with a smaller velocity because the acceleration of gravity is less on the moon. **b.** The ball will take more time.

8. **a.** In the equation $d = \frac{v_f^2 - v_i^2}{2g}$, the relationship between d and g is an inverse one. For instance, if g increases by three times, or $d = \frac{v_f^2 - v_i^2}{2(3g)}$, d becomes 1/3. Therefore, a ball on Dweeb would rise to a height of only one-third that on Earth. **b.** With $v_f = 0$, the value d is directly proportional to the square of initial velocity, v_i. That is,

$$d = \frac{v_f^2 - (3v_i)^2}{2g}.$$

On Earth an initial velocity three times greater results in a ball rising nine times higher. On Dweeb, however, the height of nine times higher would be reduced to only three times higher because of d's inverse relationship to a g that is three times greater.

9. **a.** Rock B hits the ground with a greater velocity. **b.** They have the same acceleration, that of gravity. **c.** Rock B

1. 8.0 m/s^2
2. **a.** 247 m/s^2
   b. -207 m/s^2
3. **a.** 6 m/s^2
   b. 0
   c. -2 m/s^2
   d. -4 m/s^2
4. Refer to Problems and Solutions Manual.
5. 33 m/s
6. **a.** Refer to Problems and Solutions Manual.
   b. 8.0 m
   c. 32 m
   d. 110 m
   e. 4 m/s^2
   f. 0 constant velocity
7. **a.** The fist moves downward at about -13 m/s for about 5 ms, then comes to a halt.
   b. 5.3×10^3 m/s^2
   c. Acceleration is about 530 g.
   d. -8 cm; this agrees with the position-time graph, which shows a net displacement of -8 cm.
8. **a.** 607 m/s
   b. 1.83 times the speed of sound
9. 7.0×10^4 m/s
10. 9.2×10^2 m
11. 1.7×10^3 m
12. **a.** 43 m
    b. 43 m
13. **a.** and **b.**

Car	Velocity (m/s)	Displacement (m)
A	12	12
B	11	11
C	16	16
D	24	24

    c. Displacement and velocity are numerically the same.
14. 1.2 s
15. **a.** and **b.** Refer to Problems and Solutions Manual.
    c. Refer to Problems and Solutions Manual; -20 m/s, -39 m/s; yes
    d. Refer to Problems and Solutions Manual; a straight line
    e. -4.9 m/s^2 Slope is ½ g
    f. Yes
16. 71 m/s
17. **a.** 1.4×10^2 m
    b. 5.5×10^2 m
18. **a.** 24 s

Chapter 4 pp 81-85

19. a. 5.00 s
 b. 388 m
 c. −93 m/s
20. a. 3.1×10^8 m/s^2
 b. 11×10^{-6} s
21. a. No collision
 b. Refer to Problems and Solutions Manual.
 c. Collision occurs.
22. 1.6 m thick
23. 29 times *g*
24. 2×10^5 m/s^2
25. a. Yes. It hits the barrier.
 b. 22 m/s
26. a. and b. Refer to Problems and Solutions Manual.
 c. slope = 0.083 s^2/m
 1/slope = 12 m/s^2
 d. Yes, −6 m/s^2

1. a. gravitational force b. gravitational force c. strong nuclear force d. electromagnetic force

2. a. An object at rest tends to stay at rest if no outside force acts on it. b. Newton's first law says that the state of motion of the physics book will change if a net force acts on the book. The force from your hand is greater than any opposing force such as friction. With a net force on it, the book slides in the direction of the net force. c. When your hand no longer applies a force on the book, the net force on the book is now a frictional force in a direction opposite to the book's motion, so it eventually comes to a stop. d. The book would remain in motion if the net force acting on it were zero. For example, remove friction.

3. A large force is required to accelerate the mass of the bicycle and rider. Once the desired constant velocity is reached, a much smaller force is sufficient to overcome the ever present frictional forces.

4. The rock does pull on Earth, but Earth's enormous mass would undergo only a minute acceleration by such a small force. This acceleration would go undetected.

5. Their total mass would be the same, 3.0 kg. Their weight would be ten times greater.

6. The rock would be easier to lift on the moon. The weight of the rock on the moon is less than on Earth since the acceleration due to gravity is less on the moon. $W = mg$. There is no difference in force needed to throw the rock horizontally since the force depends only on the acceleration of the rock and its mass. $F = ma$.

7. Friction between the hand cart and carton supplies the force.

8. In both cases, the tendency of the package to remain at rest or in motion is the result of inertia. More specifically, if the frictional force between the package and the seat is not large enough to accelerate the mass of the package at the same rate as the bus is accelerating, then the bus will "outrun" the sufficient frictional force to decelerate the package at the same rate as the bus will result in the package "outrunning" the bus.

Chapter 5

pp 104-107

$a = \frac{v_f^2 - 2613 m/s^2}{2(15.5 m)}$

45 m/s²

9. No. It only means the forces acting on it are balanced and the net force is zero. (With an object hanging on a rope, the weight of the object is balanced by the tension in the rope.)

10. Yes. Its velocity changed direction, thus it was accelerated and a force is required to accelerate the basketball.

11. a. The frictional force of air resistance suddenly becomes larger than the gravitational force. The velocity of the sky diver drops to that of her terminal velocity. b. The frictional force of air resistance and the gravitational force are equal. Their sum is zero, so there is no longer any acceleration. The sky diver continues downward at a constant velocity, her terminal velocity.

APPLYING CONCEPTS

1. All are examples of the electromagnetic force.

2. a. The car is suddenly accelerated forward. The seat accelerates your body, but your neck has to accelerate your head. This can hurt your neck muscles. b. The headrest pushes on your head, accelerating it in the same direction as the car.

3. A soft lead pencil would work better because it would require less force to make a mark on paper. The magnitude of the action-reaction force pair could push the astronaut away from the paper.

4. The equal and opposite forces referred to in Newton's third law are acting on different objects. The horse would pull on the cart and the cart would pull on the horse. The cart would have an unbalanced net force on it (neglecting friction) and would thus accelerate. Moral: Never teach a horse only a little physics.

5. Free fall, move to the moon, climb a mountain. Each of these will decrease the acceleration due to gravity and weight will be lost. $W = mg$.

6. The friction of the tires on the road makes it possible for the road to exert the force on the dragster.

7. Since friction depends on the nature of the surfaces (book/table) and the force pushing the surfaces together (book's weight), both would produce identical amounts of friction.

8. [continued] depends on the nature of the surfaces in contact and the normal force. In the lab on the moon, F_W would be less, therefore F_N, the action-reaction partner, would be less. Therefore, μ would be correspondingly less.

9. Yes. The frictional force is greater than the normal force. Yes. The frictional force is less than the normal force. Both the frictional force and the normal force would be needed.

PROBLEMS

1. a. 45 m/s²; b. 3.9×10^4 N c. 3.1×10^3 N; d. inertia mass
2. 33.02 m/s²; 163.0 m/s
3. No, the acceleration during the first half-second was 45 m/s² (problem 1) and the acceleration for the full time was 33.02 m/s² (problem 2).
4. -5×10^3 N, upward
5. 3.1×10^3 N
6. 6.3×10^3 N
7. 33 m
8. a. 14 m/s; b. 3.2×10^3 N
9. 6.6×10^{-25} m/s²
10. -2.0 m/s²
11. a. 95.0 kg; b. 929 N; c. 95.0 kg; d. 934 N; e. "mass-in"
12. 250 kg
13. 10.5 m/s², down
14. -1.13×10^4 N, opposite direction of motion
15. 0.255
16. 0.400
17. -1 m/s²
18. 5.3×10^4 N
19. No, the sack will rip.
20. a. 1.2 m/s²; b. -0.63 m/s² c. stopping, lower acceleration; d. scale reads less than 836 N, reads 836 N, then reads more than 836 N
21. 0.68 m/s²
22. a. 4.9×10^2; b. 150 N, static friction; c. 49 N, sliding friction d. 2.0×10^2 N
23. a. 10 N; b. 0.20
24. 1.5 m/s²
25. 4.8 m/s²
26. a. 9.8 m/s², up; b. 98 m. c. -49 N, down; d. 1.0 × 10 s
27. a. Refer to Problems and Solutions Manual for Diagram b. upward; c. 2.0 m/s²
28. a. 5.88 m/s²; b. 15.7 N
29. a. 3.27 m/s²; b. 26.1 N

APPLYING CONCEPTS

The International System of Units allows scientists all over the world to make measurements in the same system. Thus scientists know exactly what is meant by measurements made by other scientists.

2. seconds, time; meters, length; and kilograms, mass

3. The derived units are combinations of the fundamental units.

4. **a.** centimeter **b.** millimeter **c.** kilometer

5. the precision of a measuring device, which is limited by the finest division on its scale

6. Student answers will vary, but could include the following.
a. 365 days in a year **b.** The length of a meter stick is 1003.9 mm.

7. The final digit is estimated.

8. **a.** Zeros are necessary to indicate the magnitude of the value but there is no way of knowing whether or not the instrument used to measure the values actually measured the zeros. The zeros may serve only to locate the six.
b. Write the number in scientific notation, including only the significant digits.

9. The slope of a linear graph is the ratio of the vertical change to the horizontal change, or rise over run.

10. **a.** Longer reaction distance because $d = vt$ and t is larger. **b.** Larger slope because the vertical distance increases more rapidly with speed.

11. Temperature is the independent variable; volume is the dependent variable.
a. temperature **b.** volume

12. **a.** parabolic **b.** Linear, since y is being plotted versus the square of x, not x.

13. **a.** inverse relationship **b.** direct relationship **c.** direct relationship with the square of v

14. **a.** hyperbola **b.** straight line **c.** parabola
Make sure that the terms on both sides of an equation have the same units, and check that the problem is set up correctly.

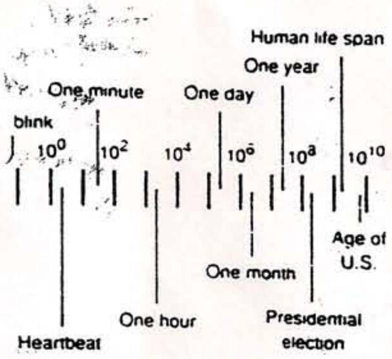
APPLYING CONCEPTS

1. **a.** Student answers will vary. Two possible answers: $\frac{g}{cm^3}, \frac{kg}{m^3}$.
b. derived unit
c. $\frac{kg}{m^3}$

2. Student answers will vary, but could be about
a. 1 cm
b. 0.1 mm
c. 3 m
d. 1 km

3. Student answers will vary.

4. Student answers will vary, but could include some of the following.



5. A meter stick's smallest division is a millimeter. Both answers should reflect a measurement to the nearest tenth of a centimeter, for example, 84.0 cm and 83.8 cm.

6. **a.** less precise
b. more accurate

7. Only like terms can be added or subtracted. 5 m and 1 s cannot be added; but divided, 5 m/s becomes a velocity.

8. Negative, because the change in vertical distance is negative for a positive change in horizontal distance.

9. Zero. The change in vertical distance is zero.

10. Solve for k: $kv^2 = d$, $k = d/v^2$. The units of k are $m/(m/s)^2 = s^2/m$.

11. Answers will vary according to the relationship chosen.

12. **a.** Lower density means faster speed, so the rock falls faster in air.
b. Since a vacuum would have a zero density, the rock should fall infinitely fast. Nothing can fall this fast.

PROBLEMS

1. **a.** 5×10^{24} m
b. 1.66×10^{-19} m
c. 2.033×10^{9} m
d. 1.030×10^{-7} m
2. **a.** 0.423 m
b. 6.2×10^{-12} m
c. 2.1×10^{4} m
d. 2.3×10^{-5} m
e. 2.14×10^{-4} m
f. 5.70×10^{-7} m
3. 0.31 mg, 1021 μg, 0.000 006 kg, 11.6 mg
4. **a.** 6.12×10^{9} s
b. 2.94×10^{-6} m
c. 1.250×10^{-4} kg
d. 7.50×10^{7} g
5. **a.** 3
b. 1
c. 4
d. 5
6. **a.** 3
b. 1
c. 3
7. 9.4×10^{3} mL, 108 m, 51 mm
8. **a.** 34.7 m
b. 25.022 m
c. 46.00 cm^2
d. 3.1 kg
9. **a.** 2.9×10^{9} m^2
b. 2.0×10^{5} m/s
c. 1.3×10^{-6} km^2
d. 1.9×10^{2} kg/m^3
10. **a.** 7.4 mm
b. 49.6 m^2
c. 70.4 kg
11. 69.2 m^2
12. **a.** 101.6 m
b. 584 m^2
13. 2.4×10^{2} m^3
14. 362.1 m
15. 48.2 kg
16. **a.** (a) 80 g, (b) 260 g, (c) 400 g
b. (a) 37 cm^3, (b) 11 cm^3, (c) 7 cm^3
c. The steepness represents the increased mass of each additional cubic centimeter of the substance.
17. **a.** Refer to the Problems and Solutions Manual.
b. a straight line
c. $M = mV$, where m is the slope.
d. mass/volume; density
18. **a.** Refer to the Problems and Solutions Manual.
b. The acceleration varies directly with the force.
c. $F = ka$
d. $m/s^2 \cdot N$

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Solutions Manual.

b. hyperbola

c. Acceleration varies inversely with the mass.

d. $a = c/M$

e. $kg \cdot m/s^2$

20. a. $75.7\ cm^3$

b. $1.46 \times 10^3\ g$

21. a. $l = \dfrac{gT^2}{4\pi^2}$

b. $g = \dfrac{4\pi^2 l}{T^2}$

22. a. 683 g

b. $6.3\ cm^3$

23. 6.02×10^{18} km

24. a. 1.08×10^5 km/h

b. 3.00×10^4 m/s

25. a. 1.67×10^3 km/h

b. 464 m/s

26. 1.4 m/s

27. a. 0.50 km

b. 0.20 h

28. $0.12 \dfrac{dm^3}{h}$

29. Each pizza costs 30 cents more to make.

Answer To

THINKING PHYSIC-LY

No. Just because a calculator gives an answer to nine places, it does not mean that all places are valid. In this case, the numbers must be rounded to the nearest hundredth.

1. Vectors are added head to tail. The resultant is drawn from the tail of the first vector to the head of the last vector. The head of the resultant vector coincides with the head of the last vector added.

2. You may move it, but you cannot rotate it or change its length.

3. The resultant is a single vector that can replace two or more vectors. It has the same effect as the sum of the original vectors.

4. No. They are still there. The object acts as if just one force, the resultant force, is acting on it.

5. It is not affected since vectors can be added in any order.

6. Vectors A and B could represent two forces that have the same size, but different directions.

7. Hang a weight on a string. The string defines the vertical direction. An object also falls vertically. Horizontal is perpendicular to this direction.

8. When two or more forces act concurrently on an object and their vector sum is zero, the object is in equilibrium.

9. Find the resultant of the forces. The equilibrant will be the same size, but the opposite direction of the resultant.

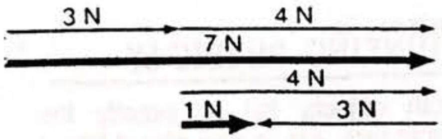
10. Yes. Newton's first law permits motion as long as an object's velocity is constant. It cannot accelerate.

11. The vector sum of forces forming a closed triangle is zero. If these are the only forces acting on the object, then the net force on the object is zero and the object is in equilibrium.

12. a. One component is parallel to the inclined plane and the other is perpendicular to it. b. $F_{\parallel} = W \sin \theta$. $F_{\perp} = W \cos \theta$, where W is the weight of the book.

Answers To
APPLYING CONCEPTS

1. 10 mm
2. 15 N
3. largest resultant: 3 N + 4 N = 7 N; smallest resultant: 4 N − 3 N = 1 N



4. a. opposite directions; b. No. Two unequal forces can never add to zero.

5. As the angle between two parallel vectors increases, the resultant vector decreases.

6. a. side A; b. side B; c. Side A and side B have the same length.

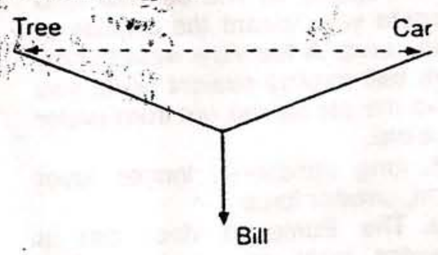
7. Yes. Lower the handle to make the angle between the handle and the horizontal smaller.

8. the component perpendicular to the ground

9. The net force is zero.

10. When stretching a clothesline or strand of wire between two posts, there is no perpendicular component upward to balance the weight of the clothesline or wire. All the force exerted is horizontal to the weight. Stretching it to remove the last of the slack is an attempt to reduce the flexibility of the clothesline or wire and to increase the internal forces holding the line together; hence the need for superhuman strength.

11. Method *b*. Vector consideration shows that if the rope is nearly straight, the car and tree provide forces that are much greater than the driver force.



12. a. 45°; b. 0°; c. 90°

13. The one that begins to slide at the larger angle has the greater coefficient of static friction.

PROBLEMS

1. 33 N, east;

3. a. 25 N, upward; b. 175 N, downward

4. a. 250 km/h, in direction of plane; b. 150 km/h, in opposite direction of plane

8. 3.5 km;

9. 42 m, 315°;

10. 509 km, 259°;

11. 5 km, 307°;

12. 24.2 N, 108°;

(from bank)
b. 30 s; c. 1.8×10^2 m

14. a. 34°; b. 90 s; c. 5.4×10^2 m; d. 90 s

15. 230 km/h, 76°

16. 1.1×10^2 N, 37°

17. a. 4.1 m/s, 67° (from bank) b. 63 s; c. 1.0×10^2 m

18. 16 m/s², 67° (up from horizontal)

19. a. 65 m/s; b. 58°

21. F_h = 65 N; F_v = 65 N

22. 108 N

23. a. 2.2 m/s²; b. 340 N, up

24. 13 N

25. 79 km, 47°

26. a. 110 N; b. 107 N; c. 97 N; d. 81 N; e. +30 N

27. 279 N, up

28. a. 12 m/s, 90°; b. 6.0 m/s, 0°

29. 74 N, 253°

30. 34 N, 223°

31. a. $T_1 = T_2$ = 150 N; b. $T_1 = T_2$ = 106 N; c. decrease toward 75 N

32. 433 N, right

34. 123 N

33. a. 51°; b. 1.4×10^2 N, up

20. 158 km/h, 18° west of south

35. a. 111 N; b. zero, constant velocity; c. 100 N, down plane; d. 0.327

36. 11 N, up plane

37. a. 0.13 m/s²; b. 0.452; c. no

THINKING PHYSIC-LY

Only the force perpendicular to the barbell contributes to lifting it. A grip in which the arms are extended straight forward from the body, so that all the force exerted is perpendicular to the bar, will exert less force on the weightlifter's arms. Spreading the arms so that the bar is gripped closer to weights reduces the component of force perpendicular to the bar. The lifter must exert more total force for the perpendicular component to equal the force exerted when the arms are perpendicular to the bar.

Chapter 6 Vectors pp 128-131

1. Up is positive and down is negative. **a.** The greatest vertical velocity occurs at point A. **b.** The horizontal velocity at all points is the same. Horizontal velocity is constant and independent of vertical velocity. **c.** The least vertical velocity occurs at point E. **d.** The curve is a parabola.

2. No. The horizontal component of motion does not affect the vertical component.

3. The plane will be directly over the flare when the flare hits the ground. Both have the same horizontal velocity.

4. **a.** No. Going around a curve causes a change in direction of velocity. Thus, the acceleration cannot be zero. **b.** No. The magnitude of the acceleration may be constant, but the direction of the acceleration changes.

5. Circular motion results when the direction of the force is constantly perpendicular to the instantaneous velocity of the object.

6. along the string toward the center of the circle that the yo-yo follows

7. The walls of the tub push the clothes toward the center of the tub. Some of the water in the clothes is not pushed toward the center of the tub, and goes out through the holes in the wall of the tub. Check out the pattern in the clothes next to the wall right after the spin cycle stops.

8. A specific torque is necessary to unstick a bolt. By increasing the length of the handle (torque arm) of the wrench, a smaller force is necessary for the same torque.

9. The period of a pendulum, and any vibrating object, is the time required for one vibration. The amplitude is the distance from rest position to the point of greatest displacement.

10. Use the equation

$$T = 2\pi\sqrt{\frac{l}{|g|}},\ g = \frac{4\pi^2 l}{T^2}.$$

Measure the length of the pendulum and its period, and calculate g.

11. at the bottom of the swing

12. According to Newton's laws, net force = zero means acceleration is zero. Passing through the equilibrium position, the acceleration has become zero and the velocity is maximum.

1. -20 m/s, where the negative sign indicates down

2. **a.** No change in time—the time it takes to hit the ground depends only on vertical velocities and acceleration. **b.** higher horizontal speed, longer horizontal distance

3. Yes. In fact the monkey would be safe if it did not let go of the branch. The vertical acceleration of the dart will be the same as that of the monkey. Therefore, the dart will be at the same vertical height when it reaches the monkey.

4. 6.0 s; 3.0 s up, and 3.0 s down

5. Both speed and angle of launch matter, so height does make a difference. Maximum range is achieved when the resultant velocity has equal vertical and horizontal components; in other words, a launch angle of 45°. For this reason, height as well as speed affect the range.

6. Nothing—the size of the centripetal acceleration is independent of the mass.

7. **a.** The ball will land in your hand since you, the ball, and the car are all moving forward with the same speed. **b.** The ball will land beside you, toward the outside of the curve. A top view would show the ball moving straight while you and the car moved out from under the ball.

8. long handle—a longer lever arm, smaller force

9. The European door has a shorter lever arm and requires more force.

10. Since $T = 2\pi\sqrt{\frac{l}{|g|}}$, slide the bob down to lengthen the pendulum and increase the time interval.

11. $T = 2\pi\sqrt{\frac{l}{|g|}}$, so with g smaller, T would be longer.

PROBLEMS

2. 32 m
3. **a.** 0.500 s; **b.** 0.800 m/s
4. 33 m; 7.3 m
5. **a.** 14.3 s; **b.** 496 m
6. 6.6 m/s
7. 3.2 m
8. **a.** 32 m; **b.** 2.1×10^2 m
9. 31 m/s, 45°
10. **a.** 0.2 s; **b.** ahead
11. 11.8 m/s, 51.0°
12. 108.3 m
13. **a.** 9.65 m/s^2; **b.** 5.94×10^3 N
14. **a.** 51 m/s^2; **b.** 3.6×10^2 N
15. **a.** 6.3 N; **b.** 25 N; **c.** 4:1
16. **a.** toward center; **b.** 0.61 m/s^2; 1.2 m/s^2; 1.8 m/s^2; **c.** friction; **d.** 15 cm
17. **a.** 2.64×10^7 m/s^2; **b.** 2.64×10^4 N; **c.** 4.78×10^{-4} s
18. **a.** 14 m/s; **b.** 98 m/s^2; **c.** drum wall; **d.** 0.10
19. **a.** 465 m/s; **b.** 3.3 N; **c.** 9.5×10^2 N
20. 15 m/s
21. **a.** 1.6 s; **b.** 2.7 m; **c.** $T = \sqrt{l}$
22. 0.16 m

Answers To
USING YOUR GRAPHING CALCULATOR

1. Set the range values (RANGE 0 100 10 0 100 10)

2. Clear the graph (Cls EXE)

3. Graph the equation of the path of the ball: $y = -4.9\left(\frac{x}{46\cos 40°}\right) + x\tan 40° + 1$ $= 0.0039x^2 + 0.84x + 1 = 45.2$ (GRAPH $-0.011 \times x^2 + 1.2$ X + 1.0 EXE)

4. Trace along the graph to $x = 96$ and find y. (TRACE -> X <-> Y)

Answer: The ball is 45 m above the ground. It clears the wall. (This is an unrealistic answer, showing that air resistance can't be ignored in this situation.)

Answers To
THINKING PHYSIC-LY

Both objects fall at exactly the same rate. Since one object has a horizontal velocity, the two objects get closer to each other and, if the canyon is deep enough, they hit.

Chapter 7. Motion in 2 Dimensions [illegible]

EVIEWING CONCEPTS

1. The path of Io is an ellipse ith Jupiter at one focus.

2. Since Earth moves more ly in its orbit during summer, Kepler's second law it must be rther from the sun. Therefore, arth is closer to the sun in the inter months.

3. No. The equality of area swept ut per unit time applies to each lanet individually.

4. Newton knew that the moon ollowed a curved path, therefore it vas accelerated, and that a force s required for an acceleration.

5.

$F = G\frac{m_1 m_2}{d^2}$, m_1 = Earth's mass

$a = \frac{F}{m_2}$, m_2 = object's mass

$a = G\frac{m_1}{d^2}$

The acceleration is independent of the object's mass. This is because heavier objects require more force to accelerate at the same rate.

6. period and orbital radius of at least one satellite

7. Orbital motion of a planet does t depend on its mass, and can- ot be used to find the mass. A satellite orbiting the planet is nec- essary to find its mass.

8. He very carefully measured the masses, the distance between the masses, and the force of at- traction. He then calculated G us- ing Newton's universal law of grav- itation.

9. gravity

10. its speed: It is falling all the time.

11. only on the distance from Earth and the mass of Earth

12. Yes; the chairs are weightless but not massless. They still have inertia.

13. A force of 5 g means that an astronaut's weight is 5 times heav- ier than it is on Earth. The force exerted on an astronaut is 5 times the force of Earth's gravitational force.

14. The units of $\frac{F}{m}$ are

$$\frac{N}{kg} = \frac{kg\ m/s^2}{kg} = m/s^2$$

15. Einstein's view is that gravity is an effect of the curvature of space as a result of the presence of mass, while Newton's view of tween objects. Thus, according to Einstein, the attraction between Earth and the moon is the effect of the curvature of space caused by their combined masses.

APPLYING CONCEPTS

1. See Figure 8–15. Only *d* is possible. *a* and *b* do not have sun at a focus; *c* does not have planet in plane of ellipse.

2. According to Newton, $F \propto \frac{1}{d^2}$. If the distance is doubled, the force is one-quarter.

3. No. The forces constitute an action-reaction pair, so under New- ton's third law, they are equal and opposite.

4. Since $\frac{T^2}{R^3} = \frac{4\pi^2}{GM_s}$, if the mass of the sun, M_s, is doubled, the ratio will be halved.

5. Nothing. G is a universal con- stant and it is independent of Earth's mass.

6. a. $v = R_e\sqrt{g/r}$, so, small. b. decrease: The drag will slow it down causing its orbit to decay, so, $v = R_e\sqrt{g/r}$ does not apply.

7. Since $T = 2\pi\sqrt{r^3/Gm}$, if the orbital radius increases, so will the period.

8. Since $T = 2\pi\sqrt{r^3/Gm}$, as the mass of the planet increases, the period of a satellite will decrease, and since Earth has a larger mass, Earth's satellite will have the smaller period.

9. $d = R_E + R_E = 2R_E$, so,

$$a = g\left(\frac{R_E}{2R_E}\right)^2 = \frac{1}{4}g.$$

10. The value of *g* would double.

11. $g \propto \frac{m}{d^2}$ 300 times the mass and 10 times the radius;

$g \propto \frac{300}{(10)^2} = 3$ times Earth's acceleration due to gravity.

12. It will also double.

13. a. Her mass increased. b. The ratio remained constant because it is equal to the gravitational field at that location.

PROBLEMS

1. 12 yrs
2. 19 r_E
3. 0.724 r_E
4. 23 yrs
5. 0.35 T_m
6. 6.1×10^{-9} N
7. 4.17×10^{23} N
8. 5.84×10^{-10} N
9. ...
10. 6.5×10^{-8} N
11. a. 491 N
    b. 490 N
12. 9.01×10^{-31} kg
13. $m_1 = 0.37$ kg
    $m_2 = 0.75$ kg
14. a. 6.0×10^{24} kg
    b. 5.5×10^3 kg/m^3
15. 1.0 to 2.3
16. 100 N
17. 1.989×10^{30} kg
18. 5.6×10^{26} kg
19. 6.3×10^{24} kg
    very close
20. a. 3.07×10^3 m/s; b. 24.0 h
21. a. 1.2×10^2 min; b. $1.6 \times 10^{\cdot}$ m/s
22. a. 0.2 m/s^2; b. 2×10^1 N
23. a. 1.80×10^3 N; b. 800 N
24. 2.65×10^3 km
25. a. 7.0 s; b. 2.8 s
26. 6.68 N/kg
27. a. 2.0×10^{20} N;
    b. 0.0028 N/kg
28. 352 N

THINKING PHYSIC-LY

1. In order to "drop" an object down to Earth, you would have to launch it backward at the same speed that you are traveling in your orbit. With respect to Earth, its speed perpendicular to Earth's gravity would be zero, and it could then "drop" down to Earth below. However, the object is likely to burn up as a result of friction with Earth's atmosphere on the way down.

2. The satellite is positioned as close to the equator as possible so it doesn't appear to have much north-south movement. Because it is placed at that distance, the sat- ellite has a period of 24.0 h. Any closer, its period would be less than 24.0 h and it would appear to move toward the east. Any farther, the period would be longer than 24.0 h.

Answers To
USING A GRAPHING CALCULATOR

1. Set the range values (RANGE 6400 6600 50 9 10 .5).
2. Clear the graph (Cls EXE).
3. Graph the equation (GRAPH 4.0 EXP 8/x^2 EXE).
4. Trace along the graph to the three *x*'s and find the *y*'s (TRACE -> *x* <-> *y*).

Answers: 9.77 m/s^2, 9.73 m/s^2, 9.46 m/s^2, 9.18 m/s^2

Chapter 8 pp171 –175

1. Yes. In order for a bullet to have the same momentum as a truck, it must have a higher velocity such that $mv_{bullet} = mv_{truck}$.

2. a. The pitcher and catcher exert the same impulse on the ball, but the two impulses are opposite in direction. b. The catcher exerts the larger force on the ball, because the time interval over which the force is exerted is smaller.

3. No net force on the system means no net impulse on the system and no net change in momentum. However, individual parts of the system may have a change in momentum as long as the net change in momentum is zero.

4. Cars are made with bumpers that retract during a crash in order to increase the time of a collision, reducing the force.

5. An isolated system has no external forces acting on it.

6. A conservation law states that a quantity is the same before and after an interaction.

7. Momentum is conserved. The change in momentum of gases in one direction must be balanced by an equal change in momentum of the spacecraft in the opposite direction.

8. The eight ball must be moving with the same velocity that the cue ball had just before the collision.

9. a. The momentum of a falling ball is not conserved because there is a net external force, gravity, acting on it. b. One such system in which total momentum is conserved includes the ball plus Earth.

10. The internal force of a car's brakes can bring the car to a stop by stopping the wheels and allowing the external frictional force of the road against the tires to stop the car. If there is no friction, for example, if the road is icy, then there is no external force and the car does not stop.

Chapter 9

... If the smaller force acts for a long enough time, it can provide a larger impulse.

2. You should move your hands in the same direction the ball is traveling to increase the time of the collision, reducing the force.

3. The bullet is in the rifle a longer time, so the momentum it gains is larger.

4. His momentum is transferred to Earth. Both Jim and Earth together must be considered as a system in order to use conservation of momentum.

5. When the gas pistol is fired in the opposite direction, it provides the impulse needed to move the astronaut toward the capsule.

6. Consider the system to be the ball and wall (and Earth). The wall and Earth gain some momentum in the collision.

7. By shooting mass, exhaust gas, at high velocity in the same direction in which you are moving, its momentum would cause your ship's momentum to be decreased.

8. If the two trucks had equal masses, they would have moved off at half the speed. Thus the moving truck must have had a more massive load.

9. Held loosely, the recoil momentum of the rifle works against only the mass of the rifle, producing a larger velocity and striking your shoulder smartly. When held firmly against your shoulder, the recoil momentum must work against the mass of the rifle and yourself, resulting in a smaller velocity.

10. Momentum is conserved, so the momentum of the block and bullet after the collision equals the momentum of the bullet before. The rubber bullet has a negative momentum after impact with respect to the block, so the block's momentum must be greater in this case. Bouncing beats sticking.

11. Rebounding presents the greater danger because it requires a greater change in momentum and, therefore, a greater impulse.

THINKING PHYSIC-LY

Initially, the egg will have the same momentum and will require the same impulse to bring the egg to rest. The sagging sheet will increase the impulse action time and will thus decrease the average force, saving the egg.

1. 351 kg·m/s
2. 4.8 kg·m/s
3. 42 m/s
4. a. 60.0 N·s
   b. 20.0 m/s
5. a. 2.04×10^4 N·s
   b. 300 N
6. a. 2.35×10^4 kg·m/s
   b. 2.6×10^4 N
7. 2.6×10^2 N
8. -2.5×10^2 N
9. 1.10×10^3 kg
10. 1.3×10^3 s
11. 30.0 s
12. a. 5.0×10^{-2} s
    b. -4.0×10^3 N
    c. 4.1×10^2 kg: no
    d. Holding a child is dangerous to the child.
13. 888 kg·m/s at 43.6° below horizontal
14. a. 63 kg·m/s
    b. 63 N·s
    c. 2.0×10^4 N
    d. 4.0×10^3 N
15. a. 1.5×10^2 kg·m/s
    b. 1.5×10^2 N·s
    c. 3.0×10^3 N
    d. Force is about 5 times the weight.
16. a. 7.8×10^2 kg·m/s
    b. -7.8×10^2 kg·m/s
    c. 7.8×10^2 kg·m/s
    d. -7.8×10^2 kg·m/s
    e. 6.1 m/s
17. a. 1.0×10^{-3} kg·m/s
    b. -6.0×10^{-4} kg·m/s
    c. 6.0×10^{-4} kg·m/s
    d. 1.6×10^{-3} kg·m/s
    e. 16 cm/s
18. a. -1.0×10^2 kg·m/s
    b. -5.0×10^2 kg·m/s
19. 11 m/s
20. 3.4×10^2 m/s
21. 10.6 m/s
22. 5.0 m/s, west
23. 1:-1.5, the student with the smaller mass
24. 10 m/s
25. 0.041 m/s, yes
26. a. -0.500 kg·m/s
    b. -0.995 kg·m/s
27. 0.22 m/s, original direction
28. a. 3.1 m/s
    b. 1.24 m/s
    c. 1.6 s
    d. 0.99 m
29. 3.6 kg·m/s at 34°N of W: 1.8 m/s at 34°N of W
30. 5.4 N·s at 22° from original direction
31. 170 kg

REVIEWING CONCEPTS

1. Joules
2. No. The force of gravity is directed toward Earth and is perpendicular to the direction of motion of the satellite.
3. Gravity and upward, normal force only. No work is done because the motion is perpendicular to these forces. There is no force in the direction of motion because the object is sliding at a constant speed.
4. Work is the product of force and the distance an object is moved in the direction of the force. Power is the time rate at which work is done.
5. $W = \frac{J}{s} = \frac{N \cdot m}{s} = \frac{\left(\frac{kg \cdot m}{s^2}\right) \cdot m}{s} = \frac{kg \cdot m^2}{s^3}$
6. No
7. Pedals of a bike transfer force from the rider to the machine through a distance.

Answers To
APPLYING CONCEPTS

1. Each requires the same amount of work because force times distance is the same.
2. You do positive work on the box because the force and motion are in the same direction. Gravity does negative work on the box because the force of gravity is opposite to the direction of motion. The work done by you and by gravity are separate and do not cancel each other.
3. Either ramp: only the vertical distance is important. If Guy used the shorter ramp, he would have to apply more force; the longer ramp would require less force. The work done would be the same.
4. Net work is zero. Carrying the carton upstairs requires positive work; carrying it back down is negative work. The work done in both cases is equal and opposite because the distances are equal and opposite. The student might arrange payments on the basis of the time it takes to carry paper, whether up or down, not on the basis of net work done.

and the displacement is down the hall. They are perpendicular and no work is done.

6. a. Both people are doing the same amount of work because they are both climbing the same flight of stairs.
b. The person who climbs the stairs in 25 seconds expends more power, as less time is needed to cover the distance.
7. Increase the ratio of $\frac{d_e}{d_r}$ to increase the ideal mechanical advantage of a machine.
8. Your hand should be as far from the head as possible to make d_e as large as possible. The nail should be as close to the head as possible to make d_r as small as possible.
9. Reduce friction as much as possible to reduce the resistance force.

Answers To
PROBLEMS

1. 8.0×10^2 J
2. 1.2×10^4 J
3. 59.9 kg
4. 1.86×10^5 J
5. 0.80 J

8. a. 826 N
b. 1.13×10^4 J
c. -1.13×10^4 J
9. 1.20×10^4 J
10. 58.7°
11. 1.8×10^4 J

14. 518 J
15. 7.4×10^3 J
16. a. 800 J
b. 600 J
17. a. -5.53×10^3 J
b. no work
c. 5.53×10^3 J
d. no
e. 2.2 kW
18. a. 9.00×10^3 J
b. 3.00 kW
19. a. 348 W
b. 696 W
255 J
20 a. ~~2.2×10^2 J~~
b. ~~1.8×10^2 W~~ 1.3×10^2 W
21. a. 110 kJ
b. 3.14 kW
22. a. 949 N
b. 1.8×10^4 J
c. 2.3 kW
23. 1.6×10^2 W
24. 54.7 m
25. 3.68×10^2 W

26. 90 kW
27. 2.89×10^3 N
28. 2.3×10^3 N
29. a. 250 N
b. 50 N
c. 5.00×10^3 J
d. 6.00×10^3 J
e. 4.00
30. a. 1.04×10^3 J
b. 958 J
c. 92.1%
31. a. 4.00
b. 3.59
c. 89.8%
32. a. 61 N
b. 4.0
c. 83%
33. 98 J
34. 1.64×10^4 J
35. 0.50 m/s
36. a. 6.0
b. 150 N
c. 2.0 cm

Answer To
THINKING PHYSIC-LY

Yes. The higher the muzzle velocity, the larger the kinetic energy and the greater the power for a given time interval. In this case, the time interval is really smaller because of the higher velocity of the bullet, and the smaller time interval requiring more power.

1. Work is the transfer of the energy.

2. A wound-up watch spring has potential energy. Work was done to wind the spring. When running, a watch converts the potential energy of the spring into kinetic energy of the gears. When a watch runs down, its energy has been converted to heat and sound.

3. The Earth-sun system possesses both kinetic and potential energy. As a matter of fact, the two are constantly interchanging. This is the reason Earth moves faster along its orbit when closer to the sun, in accordance with Kepler's law.

4. Forces applied through a distance do work and transfer energy between points and between objects.

5. No. Mass is positive and the square of any velocity, positive or negative, is positive. The change in kinetic energy may be negative or positive.

6. Yes. The net force acting on a car, the force exerted backwards by the road, does negative work on the car, reducing its kinetic energy.

7. Yes. A baseball can have a height (potential energy) and a velocity (kinetic energy).

8. Work done by vaulter: kinetic energy of running, potential energy of bent pole, kinetic energy of rising vaulter, potential energy of vaulter at top of trajectory, kinetic energy of vaulter falling.

9. The fiberglass pole can bend more, can store more potential energy, and can transfer that energy into gravitational potential energy.

10. Yes, if the baseball is below the reference level.

11. In the potential energy of the rock that makes up the Earth: The rock is slowly compressed like a spring and suddenly releases that potential energy.

12. three times as much work

13. No, since they have different reference levels; yes, since the change in distance is the same for the same velocity.

Chapter 11

14. a. If the ball had bounced 8 m, the collision would have been perfectly elastic. b. If the ball had not bounced at all, the collision would have been perfectly inelastic. c. Some of the ball's kinetic energy is converted to heat and sound as it collides with Earth.

15. No, some of the work goes into overcoming friction.

16. The collision causes a change in momentum. The air bags increase the time over which the force of the collision acts on your body, decreasing the force. $Ft = m\Delta v$

17. a. The kinetic energy of the colliding bodies before the collision equals the kinetic energy of the bodies after the collision. b. conservation of momentum and energy c. conservation of momentum—some energy changed to thermal energy

18. Yes. The kinetic energy turns into heat and sound energy.

APPLYING CONCEPTS

1. The semi-truck has more kinetic energy because kinetic energy is directly proportional to the mass of an object.

2. Sally's car; the greater the speed, the greater the kinetic energy.

3. Direction is not important to kinetic energy. The cars have the same kinetic energy.

4. Yes. If the force is not applied through a distance, no work is done and there is no change in kinetic energy.

5. They will be equal.

6. Most of the energy goes into heating up the rug.

7. The greatest kinetic energy occurs when the satellite is closest to Earth.

8. The kinetic energy of the truck is converted to potential energy as the truck goes up the escape ramp. The loose gravel releases energy in the form of sound and heat, and additional energy is used to compact the gravel.

9. The bowling ball on Earth will have the larger potential energy because potential energy is directly proportional to gravitational acceleration, *g*.

10. Work is needed to change the potential energy of a car. By increasing the distance, *d*, the force, *F*, is reduced.

11. 50 J

12. The faster pendulum rises four times as high because the kinetic energy at the bottom becomes potential energy at the top, and kinetic energy is proportional to the square of the speed, while potential energy is proportional to the height.

13. Potential energy is doubled at the top, so kinetic energy is doubled at the bottom of the trajectory. Thus the square of speed is doubled, so speed is larger by a ratio of $\sqrt{2}/1 = 1.414$.

14. Even though the balls do not hit the ground at the same time, they have identical velocities and kinetic energies when they hit.

15. No. Since the ball does not maintain a constant acceleration throughout its entire fall, some of its energy is transformed as it works against air resistance.

16. Potential energy is greater, so *E* is greater. Thus *m* is larger.

Answers To
PROBLEMS

1. 1.25×10^5 J
2. 6.75×10^5 J
3. a. 2.3×10^3 J
   b. 5.6×10^2 J
   c. $\frac{4}{1}$
4. 203 J
5. 1.7×10^2 J
6. a. 3.50×10^3 N
   b. 7.69×10^4 J
7. a. 4.5×10^3 J
   b. $\frac{2}{1}$
   c. $\frac{2}{1}$
8. a. 2.50×10^8 J
   b. 2.50×10^8 J
   c. 2.50×10^8 J
   d. 141 m/s
9. 66 m
10. a. −345 J
    b. −345 J
    c. 34.5 m
11. a. -1.44×10^5 J
    b. -1.44×10^5 J
    c. -2.88×10^5 N
12. 2.1×10^3 J
13. 1.3×10^2 J
14. -2.75×10^3 J
15. 3.44×10^3 J
16. 20.0 m
17. 16.8 J
18. 0.102 kg
19. 26 m
20. a. 4.9×10^3 J
    b. 4.9×10^3 J
    c. 4.9×10^3 J
21. a. 2.0×10^4 J
    b. 2.0×10^4 J
    c. 45 m/s
22. a. 42 m/s
    b. 90 m
23. a. 400 J
    b. 20 m/s
24. a. 3.4 m/s
    b. 1.6×10^2 J
25. 4.1 m/s
26. 1.2×10^3 J
27. 9.39 m/s
28. a. $P_b = 15.5 \frac{\text{kg·m}}{\text{s}}$; $P_g = -15.5 \frac{\text{kg·m}}{\text{s}}$
    b. $KE_b = 2.40 \times 10^3$ J
    $KE_g = 4.00$ J
29. a. 4.0×10^6 kg·m/s
    b. 4.0×10^6 kg·m/s
    c. before: $KE_1 = 1.6 \times 10^7$ J; $KE_2 = 0$
    after: $KE = 8.0 \times 10^6$ J
    d. heat and sound
30. 39.4 m
31. 73 m/s
32. a. 7.7×10^3 J
    b. 3.5×10^2 N

Answer To
THINKING PHYSIC-LY

The longer the displacement for the same force, the greater the work done on the ball, the greater the kinetic energy of the ball, and the higher the speed.

chapter 11

... The external energy of a ball is the sum of all energy outside of the ball. The external energy of a baseball in flight is the result of its motion and position above Earth. Its thermal energy is the total kinetic and potential energy of all particles that compose the ball. The baseball will have thermal energy even if it has an external energy of zero.

2. Thermal energy is the sum of the kinetic and potential energies of the particles that make up a ball. Temperature is the measure of the average kinetic energy of the particles of a ball.

3. Since temperature is defined as the average kinetic energy of particles, by classical physics, temperature in a true vacuum is undefined because there are no particles.

4. No. The particles in a liquid have a very wide distribution of speeds. However, as the temperature increases, the average speed increases.

5. a. Either scale is correct. The difference between the scales at any temperature is 273, which is insignificant compared to 1.5×10^7 degrees. b. Yes. The scale is important. Fahrenheit would be almost double.

6. No. The metal knob and the wood are at the same temperature. However, the metal knob conducts the thermal energy of your fingers away from the point of contact much more rapidly than does the wood. Therefore, your fingers feel colder touching the metal than the wood.

7. Heat is the thermal energy that flows from the hot steel ball into the cool water. The transfer of heat causes the thermal energy of the ball to decrease, while the thermal energy of the water increases.

8. No. We measure temperature changes and infer heat transfer from these measurements.

9. No. Heat, not temperature, flows from the warmer to the colder object. The temperature changes are equal only if the product of the mass and specific heat of the two are the same.

... added energy will go into the energy of the particles, causing a change of state, not temperature.

11. Energy is released by the wax when it freezes.

12. Water will vaporize from the wet canvas cover, which requires energy. Some of the energy will come from the water in the canteen, which will lower its temperature. The rest of the energy will come from the outside air which will not be able to "warm" the water in the canteen.

13. Vaporization. Changing liquid Freon to vapor requires energy. Heat is drawn from the air in the house for this, so the air becomes cooler.

14. The scrambled egg is more disordered than the unbroken egg, so the scrambled egg has more entropy.

Answers To
APPLYING CONCEPTS

1. No. The water is at the same temperature in either case, therefore the pasta cooks at the same rate.

2. a. $T_c = T_f$, so $T_c = 9/5\ T_c + 32$, or $-4/5\ T_c = 32$, or $T_c = -40$. Therefore, $-40°C = -40°F$.
b. $T_k = T_f$ and $T_k = T_c + 273$.
By substitution,
$T_k = 9/5(T_k - 273) + 32 = 9/5\ T_k - 491 + 32$, or
$-4/5\ T_k = -459$, or $T_k = +574$.
Therefore, 574 K = 574°F.
c. Celsius and Kelvin temperatures can never be the same.

3. If the same amount of heat is removed by the ice from equal masses of methanol and water, the methanol will have a greater drop in temperature since it has a lower specific heat.

4. It takes less water than other liquids to transfer a given amount of heat to the air.

5. Aluminum. The specific heat of aluminum is higher than the specific heat of lead and it can release more heat through the same temperature change.

6. No. The more massive Block A has a larger thermal energy and can heat the water to a higher temperature.

... more easily a liquid vaporizes, the faster the energy is drawn from your skin and the cooler it feels.

8. The freezing of the water releases thermal energy that slightly warms the air and reduces the amount of heat extracted from the fruit. Also, a layer of ice over the fruit slightly insulates the fruit from the cold.

9. No. Cool air would go into the room, but the refrigerator would turn on to replace the lost cool air. The heat removed from the refrigerator is pumped back into the room through the back of the refrigerator along with waste heat. So the room warms up.

Answers To
PROBLEMS

1. −196°C
2. 14.01 K
3. a. 0.565
   b. 5.65×10^7 J/s
4. 1.6×10^4 J
5. 4.5×10^3 J
6. 1.00×10^3 J/kg·K
7. 1.59×10^4 J
8. 1.1×10^3 J
9. 171 J/kg·K
10. 63°C
11. 0.87 L
12. 12.7°C
13. 25.1°C
14. 3.7×10^2 s
15. 15 kg
16. 6.68×10^6 J
17. 4.4 kg
18. 2.47×10^5 J/kg
19. 1.56×10^5 J
20. 29°C
21. 3.09×10^4 J
22. 35.6°C
23. 291°C
24. 10 m
25. 8.8 J

Answers To
THINKING PHYSIC-LY

1. a. The iceberg. It has a larger mass.
   b. The hot cup of coffee. The particles are moving faster, on average.
2. There is no temperature difference between your own hand and your head.

Chapter 12